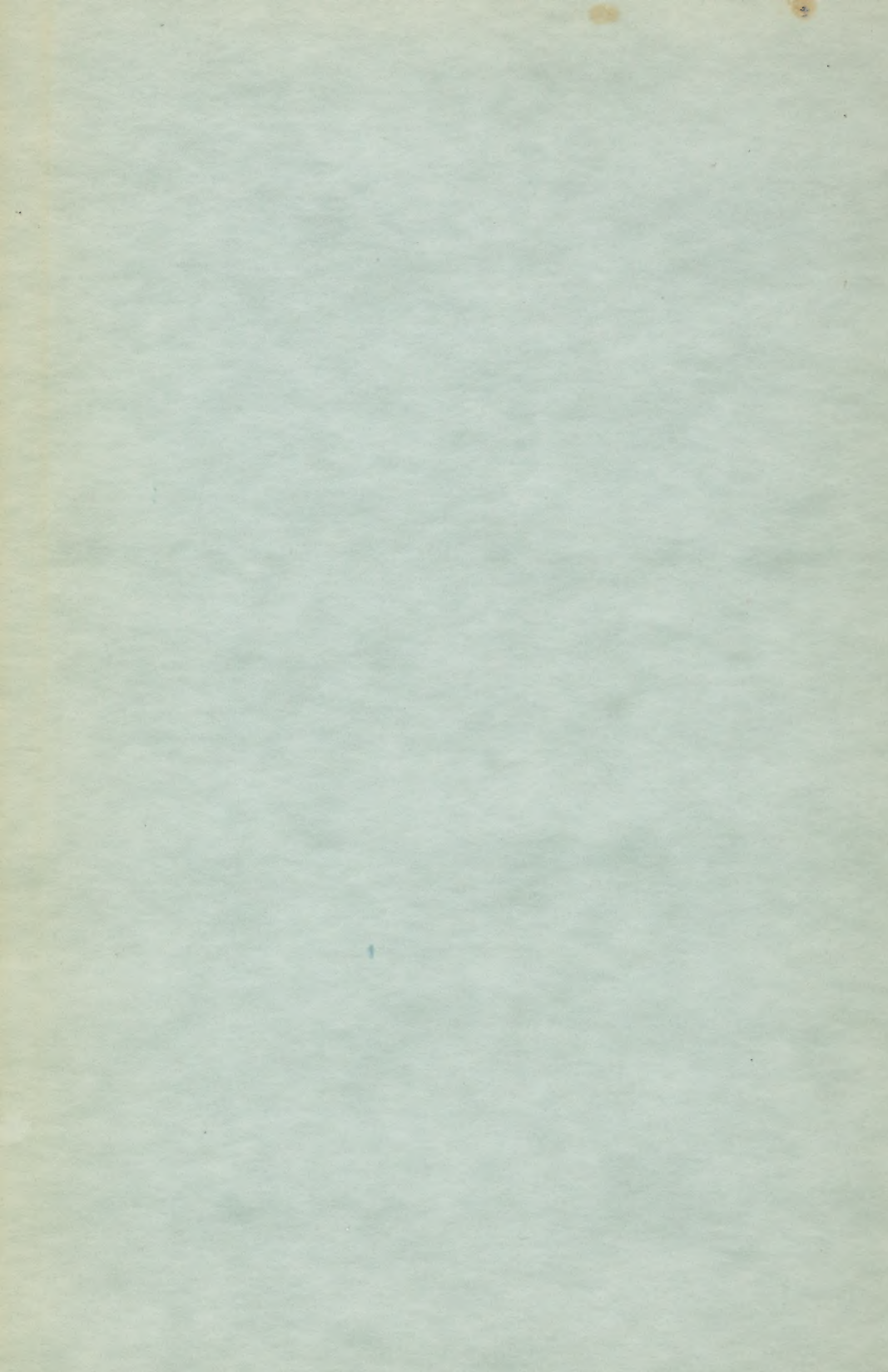


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CONN. STATE DEPT. OF HEALTH. FLUORINE AND ITS  
RELATIONSHIP TO DENTAL HEALTH.





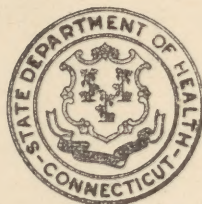






**FLUORINE**  
**and its**  
**RELATIONSHIP**  
**to**  
**DENTAL HEALTH**  
**(ABSTRACTS)**

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**1947**

Connecticut State Department of Health  
Stanley H. Osborn, M. D., C. P. H., Commissioner  
Hartford, Connecticut

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## PREFACE

The relationship of fluorine to the control of dental diseases has dominated the dental research field during recent years. Herein is presented, in abstract form, many of the authoritative papers to aid the busy practitioner in reviewing the subject.

The abstracts are given in their original form except where no such material was available and the abstract was prepared by us.

An attempt has been made to group the material as follows:

1. **Clinical** — Study on groups where fluorine is present in the domestic water supply or groups subjected to topical applications.
2. **Laboratory** — Experimental research studies.
3. **Chemistry** — Studies on the action and distribution of fluorine in the body.
4. **Toxicosis** — Reports of acute and chronic cases of fluorine poisoning.
5. **Publications of other countries.**

The back cover pages are given over to (1) a water analysis of each county in the State of Connecticut made in February 1944 and (2) a technic for the application of sodium fluoride to the teeth.

The original sources of the abstracts are:

Journal of the American Dental Association

Journal of the American Medical Association

Journal of the American Water Works Association

Journal of Dental Research

Weekly Public Health Reports of the U. S. Public Health Service

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## CLINICAL STUDIES

### DOMESTIC WATER AND DENTAL CARIES

**I. Dental Caries Study Including *L. Acidophilus* Estimation of a Population Severely Affected by Mottled Enamel and Which For The Past Twelve Years Has Used a**

**Fluoride Free Water.** By H. Trendley Dean, Philip Jay, Francis A. Arnold, Jr., and Elias Elvove. *Pub. Health Rep.* **56:** 365 (Feb. 28, 1941).

Epidemiological evidence points to inverse relationship between endemic dental fluorosis and dental caries. Whether inhibitory agent operates locally, systematically, structurally or compositionally, is not clear. Examinations made of 82 Bauxite, Ark. children from 6 to 15 years old, 42 born prior to, 40 born after water supply was changed from deep-well water containing 13 to 14 ppm. fluoride (F), to Saline R. filtered effluent, F-free. Comparative examinations also made on 50 Bauxite and 45 Benton, Ark., high school pupils using same F-free water all their lives. *L. acidophilus* counts made on both groups. Authors stress 2 points: (1) Older Bauxite group, all showing moderate to severe endemic dental fluorosis, disclosed markedly less dental caries than comparable Benton group, free of mottled enamel. (2) Cumulative increase in amount of dental caries experience with increasing years exposed to risk did not hold in Bauxite school population studied. Reversal in trend of this epidemiological constant suggests noticeable physiological influence which operated in this population and presumably was associated with change in communal water supply. This limited immunity from dental caries is seemingly not dependent upon presence of microscopic mottled enamel, because children born within several years of change in water supply, and almost free of mottled enamel, likewise disclosed low dental caries experience. Youngest age Bauxite group, those farthest removed in time from influence of "old" high fluoride water, shows highest dental caries experience in spite of their exposure to caries risk for shortest time. *L. acidophilus* counts apparently reflect difference in caries activity in several groups studied, a result seemingly consistent with clinical findings. Teeth moderately to severely affected with mottled enamel showed no tendency to rampant dental caries, even though exposed to a F-free water for past 12 years. 7 tables, 27 refs. — R. E. Noble.

**II. A Study of 2,832 White Children, Aged 12-14 Years of Eight Suburban Chicago Communities, Including *L. Acidophilus* Studies of 1,761 Children.** H. T. Dean, F. A. Arnold, Jr. and E. Elvove. *Pub. Health Rep.* **56:** 761, (Apr. 11, 1941).

Purpose of study to determine how low a fluoride (F) concentration in public water supply would be found associated with relatively low dental caries rates, and to check possible role of other constituents of water



not yet ruled out epidemiologically. Sampling and clinical examining methods described indicate thoroughness and care with which study conducted. Authors found negative correlation between F concentration of public water supply and dental caries experience of children continuously exposed to such waters. Study of 8 suburban Chicago communities discloses marked differences in amount of dental caries. Experience rates in Elmhurst, Maywood, Aurora and Joliet, whose public water supplies contain 1.8, 1.2, 1.2 and 1.3 ppm. F, respectively, were 252, 258, 281 and 323. At Evanston, Oak Park and Waukegan, using F-free water, rates were 673, 722 and 810. Using proximal surface of 4 superior permanent incisors as basis of measurement, there was 14.3 times as much of this type of dental caries in 1,008 children from Evanston, Oak Park, and Waukegan as in 1,421 from Elmhurst, Maywood, Aurora and Joliet. Differences in *L. acidophilus* counts in saliva corresponded to differences in dental caries experience in groups of communities studied. Considering relative homogeneity of these urban populations and sampling method followed, difficult, epidemiologically, to ascribe these observed differences to any cause other than common water supply. Dental caries inhibitory factor, presumably F, operative at such low concentrations (e. g., 1.2 ppm. F. in Aurora) that mottled enamel, as esthetic problem, not encountered. 15 tables, 10 figs., 9 refs. — R. E. Noble.

**V. Additional Studies of The Relation of Fluoride Domestic Waters to Dental Caries Experience in 4,425 White Children Aged 12 to 14 Years, of Thirteen Cities in Four States.** H. T. Dean, F. A. Arnold, Jr. and E. Elvove. *Pub. Health Rep.* 57: 1155, (Aug. 1942).

A comprehensive clinical survey confirmed previous findings that the incidence of dental caries is in inverse ratio to the amount of fluorine contained in the water supply. The continuous use of domestic waters containing as low as one ppm was associated with a relatively low dental caries experience. Only sporadic instances of mild dental fluorosis were found, indicating that the caries inhibiting factors associated with fluorine are effective at concentrations so low that mottled enamel ceases to be an accessory complication. No relationship could be found between the caries incidence and the hours of sunshine, the hardness of the domestic water or gross dissimilarities in diet. — R. J. H.

**Domestic Water And Dental Caries Including Certain Epidemiological Aspects of Oral *L. Acidophilus*.** H. T. Dean, et al. *Pub. Health Rep.* 54: 862, (May 26, 1939).

A detailed survey of four Illinois cities was made which so far as possible took into account all of the factors that influence dental caries. Two of the cities, Galesburg and Monmouth, whose water supply contains 1.8 and 1.7 ppm of fluoride, respectively, show low caries rates of 201 and 205 carious permanent teeth per 100 children, while nearby Macomb and Quincy, whose waters are practically fluoride free, are characterized by dental caries rates double and treble those observed at Galesburg and Monmouth. Using the approximal surfaces of the four superior incisors as a basis for measurement, there were 16 times as much interproximal caries in Macomb and Quincy as in Galesburg and Monmouth. The amount of *L. Acidophilus* in the saliva closely reflected the difference in the dental caries rates. From an epidemiological standpoint, it is difficult to ascribe the differences to any cause other than the common water supply. — J. T. F.



**Fluoride Domestic Waters And Dental Caries Experience In 2026 White Illinois Selective Service Men. C. F. Deatherage. *J. D. Res.* 22: 129, (April 1943).**

A study of 2026 white adults lends further support to the fluorine dental caries hypothesis. The average age of the group was 25.5 years. The domestic waters used by these selectees were grouped into 3 broad divisions: FLUORIDE FREE (0.0-0.1 ppm of F), SUBOPTIMAL FLUORIDE (0.5-0.9 ppm) and FLUORIDE (1.0 ppm and over). Individuals were classified according to whether they had used the domestic water in question (a) during their entire life, or (b) during the first 8 years of life only (period of dental calcification). A lower dental caries experience and a higher rate of teeth with no caries experience was observed in those using either type of fluoride water when compared with those using fluoride free domestic waters, the higher fluoride waters (1.0 ppm or over) being associated with the lowest dental caries experience. Other factors being essentially the same it is reasonable to assume that the marked differences in dental caries experienced by the several groups is attributable to the differences in the fluoride content of the domestic waters used. Attention is also called to the lower percentage of selectees rejected for military service because of dental conditions and the lower percentage using various forms of dental prosthesis, particularly dentures, in those selectees from the fluoride water areas.

**A Study of Fluoride Domestic Waters And Dental Caries Experience In 263 White Illinois Selective Servicemen Living In Fluoride Areas Following The Period of Calcification Of The Permanent Teeth. *J. D. Res.* 22: 173, (June 1943). C. F. Deatherage.**

A study of 549 white adults lends support to the fluorine dental caries hypotheses. Indicates that fluorine has an inhibitory effect on dental caries after the calcification of the permanent teeth.

|               | Fl. free | Post cal. fl. | Fl. entire |
|---------------|----------|---------------|------------|
| No. ....      | 286      | 263           | 454        |
| D .....       | 197      | 157           | 139        |
| M .....       | 385      | 337           | 220        |
| F .....       | 505      | 344           | 261        |
| Total         |          |               |            |
| DMF .....     | 1087     | 838           | 620        |
| DMF           |          |               |            |
| per 100 ..... | 345      | 318           | 136        |

**Endemic Fluorosis And Its Relation To Dental Caries. H. Trendley Dean. *U. S. Pub. Health Repts.* 53: 1443, (Aug. 19, 1938).**

Examinations of 236 nine-year old children with verified continuity of exposure showed that a higher percentage of children is caries-free in communities where domestic water supplies contain higher fluoride concentrations in comparison with communities using waters of lower concentrations. This limited immunity to dental caries seemed operative with respect to the deciduous teeth as well as the permanent teeth. Analysis of dental caries attack rates in a relatively large number of children in the three States thus far studied (So. Dak., Colo.,



and Wis.) indicates that the severity of dental caries is, in general, lower in mottled enamel areas as compared with normal areas in the same State. Since the mineral composition of drinking water may have an important bearing on the incidence of dental caries in a community, the possibility of partially controlling dental caries through the domestic water supply warrants thorough epidemiological-chemical study. — Ralph E. Noble.

**The Effect of Fluoride On Dental Caries.** D. B. Ast.  
*U. S. Pub. Health Rep.* **58:** 23, (June 4, 1943).

A complete resumé is given of all former work to date regarding fluorine as related to dental caries. Theories about its action and the importance of its presence in drinking water are described. It is proposed to test the accuracy of the caries-fluorine hypothesis by deliberately placing non-toxic doses (14.7 pounds of sodium fluoride per million gallons of water) in the public drinking water of one community, and using a comparable community with fluorine-free water as a control. The study would extend over a period of from ten to twelve years. — M. J. S.

**Mottled Enamel Survey of Bauxite, Ark., 10 Years After A Change In The Common Water Supply.** H. Trendley Dean, Frederick S. McKay and Elias Elvove. *U. S. Pub. Hlth. Repts.* **53:** 1736 (Sept. 30, 1938).

The production of an unusually severe type of endemic dental fluorosis (mottled enamel) at Bauxite, Ark. (25 mi. SW. of Little Rock; population 1800), was halted with change in the common water supply. This is the second recorded instance in the U. S. where a community has abandoned use of an otherwise satisfactory common water supply solely for the purpose of preventing development of permanent dental disfigurements among children. The efforts in each instance were successful. Article includes 3 tables, 2 figures and 12 photographs. — Ralph E. Noble.

**Further Studies On The Minimal Threshold of Chronic Endemic Dental Fluorosis.** H. T. Dean and E. Elvove.  
*Pub. Health Rep.* **52:** 1249. (Sept. 10, 1937).

Widely separate cities were selected in endemic communities and studies were conducted in an attempt to find a definite quantitative relationship between the fluoride concentration and the clinical manifestations of dental fluorosis. There was an orderly uniformity in the group response to the fluoride concentration of the water with regard to both the incidence and the percentage distribution of severity. Evidence is presented that amounts of fluorine not exceeding 1 ppm. are of no public health significance. — J. T. F.

**Chronic Endemic Dental Fluorosis.** *JAMA* **107:** 1269. (Oct. 17, 1936).

From the continuous use of water containing about 1 ppm, it is probable that the very mildest forms of mottled enamel may develop in about ten per cent of the group.



**Incidence of Dental Caries Among Aviation Cadets,**  
*W. Senn. Mil. Surgeon, 93: 461, (Dec. 1943).*

Careful clinical examinations were made of more than 7,000 aviation cadets between the ages of 18 and 27 years and records made of all carious, restored and missing teeth. Men from the Atlantic and Pacific coastlines both showed a relatively high incidence of caries, those from the central and midwestern states a considerably lower incidence. Men from Washington had the highest caries index and those from Texas the lowest. Maps are presented which lead to the possible conclusion that those cadets coming from areas where the fluorine content of the drinking water is high show the lowest incidence of dental caries. This is further evidence in favor of the fluorine-caries prevention theory. One feature worthy of note is that aviation cadets represent the most physically fit members of their age group, all coming from at least average environments, and having adequate opportunities for dental care. — D. B. S.

**Condition Suggestive of Threshold Dental Fluorosis Observed In Tristan Da Cunha. I. Clinical Condition of The Teeth.** R. F. Sognaes. *J. D. Res. 20: 303, (Aug. 1941).*

A condition, previously unreported, suggesting a threshold degree of dental fluorosis, has been observed in the inhabitants of the South Atlantic Island of Tristan Da Cunha. The lesions in the enamel appeared as opaque whitish areas possessing a smooth surface texture. Of 3,907 permanent teeth examined, 629, or 15.3 per cent, were affected with these "white spots," the incidence being highest in younger persons. Of 765 deciduous teeth, seventy-seven, or 10 per cent, were similarly marked. The anterior teeth while remarkably free from dental caries, were most frequently affected with these white areas. It seems probable that the fluorine was derived from drinking water and from the large quantities of fish consumed. — J. E. G.

**Condition Suggestive of Threshold Dental Fluorosis Observed In Tristan Da Cunha. II. Fluorine Content of The Teeth.** R. F. Sognaes and W. D. Armstrong. *J. D. Res. 20: 315. (Aug. 1941).*

Eighteen teeth, ten deciduous and eight permanent, were used for the fluorine analyses. The deciduous teeth were obtained only from those islanders changing dentition at the time of their stay on the island. The permanent teeth were extracted only when malposition or caries justified. Consequently, the material is lacking permanent teeth with the characteristic white, opaque areas.

The average fluorine content of the enamel in both dentitions was found to be 0.0140 per cent, while the deciduous and permanent dentin contained 0.0196 and 0.0270 per cent fluorine, respectively. These values are from 27 to 60 per cent higher than those of non-fluorosed sound teeth (from Minnesota) analyzed by the same method in the same laboratory. — J. E. G.

**Fluorine Therapy For Exposed Dentin And Alveolar Atrophy.** E. H. Lukomsky. *J. D. Res. 29: 649, (Dec. 1941).*

Fluorine therapy was used in the treatment of progressive alveolar atrophy. The stains and deposits were removed from the teeth and a 1

per cent solution of pure sodium fluoride was prescribed, to be used for a period of thirty days. The dose given was 5 drops of the solution three times a day, or 8 drops before meals two times a day. Under this treatment many subjective symptoms disappeared and the teeth became firm. In all of his work with fluorine, the author has never seen a case of fluorine intoxication. — J. T. G.

**The Effect of Topically Applied Sodium Fluoride On Dental Caries Experience.** J. W. Knutson and W. D. Armstrong. *Pub. Health Rep.* **58**: 1701, (Nov. 19, 1943).

Data is presented on the incidence of dental caries during the year ended May 1943 in the permanent teeth of two groups of children. One group of 289 children aged 7 to 15 years received topical applications of 2 per cent sodium fluoride solution to the teeth in the upper left and lower left quadrants of the mouth. The second group, consisting of 326 children did not receive the fluoride treatments and were carried as controls.

An analysis of the data indicates:

1. In the treated group there were 39.8 per cent less new carious teeth in the treated than in the untreated teeth.
2. The difference between the caries incidence in the treated and untreated teeth was appreciably greater in the upper than the lower teeth.
3. The number of new carious surfaces in teeth previously attacked by caries was not significantly different in the treated and untreated teeth.
4. The incidence of caries in the teeth of the untreated mouth quadrants of the treated group was not significantly different from that in the teeth of the control group. — J. T. F.

**The Effect of Topically Applied Sodium Fluoride on Dental Caries Experience. II. Report of Findings For Second Study Year.** J. W. Knutson and W. D. Armstrong, U. S. *Pub. Health Rep.* **60**: 1085 (Sept. 14, 1945).

At end of two year period. May 1944, initial caries attack on fluoride treated teeth continued to be significant, approximately 46.6 per cent less treated teeth being attacked than untreated. Also the number of additional surfaces attacked in previously decayed teeth continued to be less (25.2%) with an appreciable increase in magnitude of the difference, confirming the conclusion that fluoride treatment is as effective during second year as during the first following application.—R. L. D.



**The Effect of Topically Applied Sodium Fluoride on Dental Caries Experiences. III. Report of Findings For The Third Study Year.** J. W. Knutson and W. D. Armstrong, *U. S. Pub. Health Rep.* (Nov. 22, 1946).

This report presents data on the dental caries experience of two groups of Minnesota children receiving 7 to 15 topical applications for the three year period ending May 1945.

1. The number of permanent teeth initially attacked by caries was 36.7 per cent less in fluoride treated than in untreated teeth. This percentage difference is somewhat smaller than that observed for the first year (39.8%) and for the two year period ending May 1944 (41.4%).
2. During the third study year, initial caries attack was 22.2 per cent less in fluoride treated than in untreated permanent teeth. This yearly difference is substantially less than that observed for the second year, 46.6 per cent and for the first study year, 39.8 per cent.
3. Among permanent teeth which were carious at the beginning of the study in 1942 the number of additional surfaces which became carious during the three year period was 23.9 per cent less in treated than in untreated carious teeth. The percentage difference observed for the first study year was 12.4 per cent and for the first two year period 23.1 per cent. By individual study years there were 12.4 per cent, 25.2 per cent and 33.1 per cent less newly carious surfaces in fluoride treated than in untreated carious teeth for the first, second and third years, respectively.—F. M. E.

**The Effect of Topically Applied Sodium Fluoride on Dental Caries Experience. IV. Report of Findings With Two, Four and Six Applications.** John W. Knutson, W. D. Armstrong, F. M. Feldman. *Pub. Health Rep.* (March 21, 1947).

Data are presented on the results of using 2 per cent sodium fluoride two, four and six applications, respectively, the fluoride treatments being completed during a three month period beginning September 1943. These treatments were not preceded by a dental prophylaxis. Approximately two years after the series of applications, November 1945, the teeth of all three treatment groups were re-examined. Analysis of the data is confined to the erupted permanent teeth present at the time of the initial examination and is as follows:

1. The incidence of initial caries in permanent teeth which were non-carious at the time of treatment was 9.3, 20.1, and 21.3 per cent less in teeth treated with two, four and six applications of fluoride solution, respectively, than in untreated teeth.
2. The numbers of additional permanent tooth surfaces which became carious in teeth which were carious at the time of treatment were 16.2, 9.6 and 22.2 per cent less in fluoride-treated carious teeth given two, four and six applications, respectively, than in untreated carious teeth.

3. Comparison of the results in this investigation with those previously reported indicates that omission of a dental prophylaxis materially reduces the caries inhibiting effects of topical fluorides.  
—F. M. E.

**Effect of Sodium Fluoride Applications On Dental Caries.** B. G. Bibby, *J. D. Res.* 22: 207, (June 1943).

One-one thousandth per cent sodium fluoride applied to 438 teeth at intervals of 4 months for 2 years. 434 teeth in same mouths used as controls. Caries reduced 32 per cent in incisors, 34 per cent in premolars, 40 per cent in molars, of treated teeth. — J. T. F.

**Human Dental Caries and Topically Applied Fluorine: A Preliminary Report.** V. D. Cheyne, *JADA* 29: 804, (May 1942).

A clinical method has been devised whereby the teeth of human beings can be treated with fluorine topically. Treatment consists of thorough prophylaxis and application of approximately 1 cc of a 500 ppm aqueous fluoride solution to the surfaces of the teeth at three month intervals. Such treatment suppresses carious activity in existing lesions and moreover, is effective in preventing the development of new lesions.  
— J. T. F.

**Dental Caries and Fluorine Water.** J. M. Wisan, D. D. S., M. S. P. H. *Pub. Health News* (Dept. of Health of State of New Jersey). Vol. 27, No. 5, (October 1944).

A group of children from six communities in New Jersey, where water was found to have fluorine content of 1-2.4 p. p. m. were studied and results compared with group from 26 communities where no fluorine was found in the public water supply. All communities were suburban or rural. Data was collected by specific age.

Criteria used for determining dental conditions in the two groups were:

1. DMF rate per child by specific age.
2. Percentage of children with no DMF by age.

In fluorine areas children were divided into two groups—those living in communities before and after 4th birthday and those moving into area after 4th birthday.

Results of the above study showed in the non-fluorine area a gradual increase in DMF per child per age of from .64 at age 6 to 10.8 at age 16. In fluorine area the group moving into area after age 4 showed a gradual increase of .08 at 6 to 7.2 at age 15 to 6.2 at age 16 while the group living in fluorine communities before and after 4th birthday showed increase of from .4 at 6 years to 4.5 at 14 years to 4.2 at 16 years.

The percentage of children with no DMF teeth in non-fluorine areas declined from 69 at 6 years to 2 at 17 years. In fluorine areas the decline was from 68 at 6 years to 18 at 17 years.—R. L. D.



**Dental Caries Experience In Relocated Children Exposed To Water Containing Fluorine. I. Incidence of New Caries After Two Years of Exposure Among Previously Caries-Free Permanent Teeth, *Pub. Health Rep.* (Dec. 7, 1945).**

In the course of systematic dental examinations of persons of Japanese ancestry residing in War Relocation Authority centers, two groups of children at two different centers were examined in the summers of 1943 and 1945. Early in 1942 both groups, because of their Japanese ancestry, had been transferred with their parents from homes in Los Angeles and environs to an assembly area near Los Angeles. In the autumn of 1942 they were again transferred, 120 to a center in California and 196 to Arizona. The children in California consumed fluoride-free water, 0.1 p. p. m., a value within the error of measurement. The children in the Arizona center consumed water containing up to 3 p. p. m. of fluorine.

During the two year interval between 1943 and 1945, the 196 children were exposed to fluoride water in the Arizona Relocation Center and 120 consumed fluoride-free water in the California center. At the time of the first examination in 1943, the boys and girls of the two areas were quite similar with regard to the number of caries-free permanent teeth present in the mouth. After a two year residence in their respective areas the two groups of children showed a marked difference in the number of teeth newly attacked by caries. In the fluoride area boys who were 8 years old in 1943 developed 22 new DMF teeth per 100 caries-free permanent teeth in contrast to boys of the same age in the control area, 44 new DMF teeth per 100. The corresponding values for girls 8 years old in 1943 were 15 DMF for the fluoride group and 36 DMF for the control group. The absolute differences in incidence of new caries between the fluoride and control groups tend to diminish with advancing age for both the boys and the girls. The differences became small and variable beginning at about 12 years of age in boys and at about 11 years of age in girls. Caries incidence in children who were over 11 years of age in 1943 was not affected significantly by either the presence or absence of fluorine in drinking water.

These findings lead to the conclusion that among young children (8-10 years) transferred to an area where drinking water contained 3 p. p. m. of fluoride, the incidence of new caries experience in previously non-carious erupted teeth was reduced approximately 60 per cent below that which would be expected on the basis of the incidence observed in the control group. The data are sufficient to indicate that exposure of erupted permanent teeth of younger children to fluoride water provide a larger measure of protection against caries than does the same exposure of older children. It follows, therefore, that among teeth in the mouth at the beginning of exposure to fluorine, those most recently erupted were those most protected against caries attack.

The findings reported here are not intended to constitute an endorsement for addition of as much as 3 p. p. m. of fluorine to community water supplies for the purpose of reducing caries incidence.  
—F. M. E.

**Use of Topical Fluorine on School Age Children and Its Effect on Dental Caries. J. T. Fulton, D. D. S. and Edwin T. Tracy, B. S. *Conn. Health Bul.* 60: 55. (March 1946).**

During July 1944, 84 children, age 4-14 years, were treated topically with a 2 per cent sodium fluoride solution after a dental prophylaxis had been administered followed by a complete dental examination. The treatment was repeated six months later. Approximately a year later another dental examination, prophylaxis and topical treatment of 2 per cent sodium fluoride was administered. A control group of 93 children, homogenous in respect to those factors influencing dental decay except for the controlled variable, fluorine, were given a dental prophylaxis and a complete dental examination six months prior to the treated group.

The project was instituted as a preventive dentistry measure and the analysis is intended to show only if the primary objective, prevention of dental caries, is being accomplished and whether the data substantiate the findings of other investigators. The caries attack rate over a twelve month interval in the treated group was 3.1 while in the control group the caries attack rate was 6.6. This means that the incidence of new caries in previously sound teeth was 53 per cent less in the group treated with fluorine than in the group that did not have fluorine. The material taken from one of Knutson's topical studies shows approximately 50 per cent reduction in the 7-10 year group and 40 per cent in the 11-15 year old group. Klein in his fluorine drinking water study shows the reduction of dental caries in the younger children were approximately 60 per cent while in the older children it is only 25 per cent.—F. M. E.

**The Effects of Various Numbers of Topical Applications of Sodium Fluoride.** W. A. Jordan, O. B. Wood, J. A. Al-lison, V. D. Irwin. *J. A. D. A.*, (November 1946).

The purpose of this study was to determine the minimum numbers of applications necessary to obtain the maximum results. Three groups of children were selected from three different locations. Each child received a dental prophylaxis which included use of pumice with rubber caps, scaling, sanding interproximal spaces with strips and removing all stains. One group received one application of a 2 per cent sodium fluoride solution; another group received two applications and a third group received three applications. Findings of the three studies indicate a reduction of dental caries corresponding to the increased number of applications of sodium fluoride. However, the maximum results obtained in studies previously reported were not reached in our three treatments. It is therefore evident that more than three treatments are necessary to obtain the maximum results. On the basis of the findings of this study, we may assume that at least four treatments are necessary to accomplish the same results as were achieved in Knutson's study with the use of 7 to 15 treatments. It can be assumed, on the basis of this study and that of Knutson and Armstrong, that the minimum number of treatments needs to be 4 or more, but fewer than 8.—F. M. E.

**Fluorine and Dental Caries.** Philip Jay. *J. A. D. A.* (April 1946).

It is an established fact that there are fewer dental caries in persons continuously resident in fluoride areas during the first eight years of their life than in persons who have always resided in fluoride-free



areas. The teeth of residents of fluoride areas contain more fluorine than teeth of residents of fluoride-free areas.

Studies now underway will determine efficacy of fluoride treatment of domestic water supplies.

Use of fluorides in dentrifices and mouthwashes is not justified on basis of available information to date.—R. L. D.

**Control of Dental Caries By Artificial Fluorination of a Water Supply.** F. M. Erlenbach, E. T. Tracy, *Conn. Health Bul.* (September 1946).

Sodium fluoride in the ratio of 1 p. p. m. to one million parts water was added to the water supply of the Southbury Training School beginning April 30, 1945. Dental examinations were made on 255 children ranging in age from 5 to 16 years at time of first examination. A control group of 207 children at the Mansfield State Training School were likewise examined. At the end of one year, 187 of the 255 children at Southbury were re-examined. One hundred and forty nine of the original 207 children at Mansfield were present for re-examination one year later. The findings deal only with the dental caries experience in erupted permanent teeth present in the mouth at the time of the first examination. There were 3465 non-carious permanent teeth in the fluorine group and 2447 in the control group present at the time of the first examination. At the end of one year 103 in the fluorine group and 106 in the control group had developed one or more carious surfaces. In terms of percentage, the caries attack rates were 4.3 and 3.0 respectively. This means that the incidence of new caries in previously sound teeth was 30 per cent less in the group receiving fluorine than in the group that did not have fluorine.—R. L. D.

**Fluorine and The Deciduous Teeth.** T. A. Hardgrove, F. A. Buell, *J. A. D. A.* (January 1947).

In 1945 survey was made in Green Bay, Wisc. where fluorine content of public water was 2.3 p. p. m. and in Sheboygan, Wisc. where fluorine content was 0.05 p. p. m. to establish incidence of caries in deciduous teeth of children born and reared in fluorine areas and in children born and reared in non-fluorine areas. All kindergarten children 5-6 years old who showed continuous residence in each area where examined.

The DMF rate indicates that there were about 4 times as much caries in deciduous teeth in Sheboygan as in Green Bay. About 60 per cent of Green Bay children had no caries experience with 20 per cent in Sheboygan.

In study on economic status factor, it was determined the DMF rate was approximately 10 per cent greater in lowest economic level than in highest economic level in Green Bay. In Sheboygan the DMF rate was 26 per cent higher in lowest economic level than in highest economic level.

Fluorine apparently reduces the influence of economic status on dental caries.—R. L. D.

**A Reverse Approach To The Fluorine-Dental Caries Hypothesis.** R. A. Downs, F. S. McKay. *J. Am. Pub. Health Assoc.*, (November 1946).

The necessity for this study was brought about by repeated reports from Montrose, Colorado that the dental caries rate was extremely high, and that the city water supply contained 1.4 p. p. m. of fluorine. Our present day knowledge has amply demonstrated that a high dental caries rate and 1.4 p. p. m. of fluorine in a water supply of any community do not exist together. An examination of the high school pupils was made to ascertain the actual prevalence of dental caries among students native to that community.

|  |     |
|--|-----|
| Total students checked .....               | 406 |
| Total natives examined .....               | 77  |
| Total natives free from dental caries .... | 1   |

As the examination proceeded, however, other pupils were observed who presented typical examples of dental fluorosis, none of whom had been born or reared in the city of Montrose. These individuals came from various other communities in which fluorosed enamel was known to be endemic.

|   |    |
|---|----|
| Total fluorosed persons examined .....          | 67 |
| Total fluorosed persons free from dental caries | 27 |

Natives averaged 10.220 carious areas per person.

Fluorosed averaged 1.776 carious areas per person.

No fluorosed enamel in any of the Montrose natives.

The only conclusion that could be reached from this study was that the report which gave the fluorine content of the city water as 1.4 p. p. m. fluorine was in error. A later analysis is revealed that the correct fluorine content was 0.3 p. p. m.—F. M. E.

**1. Relation to Bone Fracture Experience, Height and Weight of High School Boys and Young Selectees of the Armed Forces of the United States.** F. J. McClure. *Pub. Health Rep.* 59:1543-58 (Dec. 1944).

The author has studied the possible skeletal effects of dietary fluorine ingested via domestic drinking waters. The data were obtained by personal interviews and a study of physical records of selected groups of 1,458 high school boys and 2,529 young adult men examined at induction centers. The selection of areas was made on the basis of previous studies of endemic dental fluorosis.

Tabulations were made of incidence and types of fractures due to occupational, domestic and traffic accidents, as well as those types associated with various sports. Height and weight data were also tabulated.

The author concludes that the data suggest strongly that no serious impairment in skeletal performance or significant variation in height and weight coincides with fluorine exposures.



## II. Fluorine Content of Urine in Relation to Fluorine in Drinking Water. F. J. McClure. *Pub. Health Rep.* 59:1575-91 (Dec. 1944).

Urine specimens were obtained from young men at induction centers and from high school boys aged 15 to 17. Current water samples from a number of the communities in which the group resided were also analyzed for fluorine.

A remarkable relationship was observed between urinary fluorine and fluorine content of domestic water. Beginning with exposures approximating 0.5 p. p. m. fluorine in the local water, urine specimens show a detectable increase in fluorine. These data provide additional evidence that fluoride domestic waters are to be regarded as the most important source of fluorine in the human diet. The data further suggest that, exclusive of drinking water, the dietary fluorine is remarkably uniform.

The author suggests that the available data appears to show that cumulative storage of fluorine as related to the low concentrations of fluorine in domestic waters is not sufficient to cause concern. An efficient urinary elimination of fluorine appears to be characteristic in areas where the water contains 0.5 to 5.0 p. p. m. fluorine.

Under these conditions, the metabolism of fluorine seems to be a normal function of the human body.

## LABORATORY STUDIES

### **Observations On Induced Dental Caries in Rats. 1. Reduction by Fluorides and Iodoacetic Acid. F. J. McClure and F. A. Arnold. *J. D. Res.* 20: 97. (April 1941).**

This paper is the first of a series reporting some observations made on rat caries at the National Institute of Health. In it are recorded some of the data collected after tests with various fluorine and iodoacetic acid concentrations incorporated in the ration and drinking water of experimental rats. Galesburg and Quincy drinking waters and water containing two ppm. of fluorine were tested on litters from rats that had received these waters prior to and during gestation and lactation. The plan to test the effects of 125 parts per million of fluorine and iodoacetic acid did not involve any prior treatment of the breeding stock. Each litter of rats was represented in each group by one or two. No distinction was made as to sex. The Hoppert, Webber and Canniff caries-producing diet (*Science*, 74:77, 1931) was fed. The rats were kept on the experiment fifteen weeks, when they were killed and the teeth examined. Only cavities found by a 22.5 power microscope in unsectioned teeth were tabulated. Results are expressed as to (1) rats affected with caries, (2) teeth affected per group, (3) tooth areas affected (Cox's method) and (4) size of cavity (Cox's method).

The results of the experiment show that Galesburg and Quincy drinking water and water containing two ppm of fluorine as sodium fluoride were inadequate to demonstrate a difference in the development of rat caries when the animals were placed on a cornmeal diet. The data do call attention, however, to a litter membership factor in rats with respect to their caries susceptibility. In other words, it appears that certain variations in rats grouped as to litter membership are truly abnormal as compared with the distribution of the data selected at random. The authors suggest that such results are significant and the entire question deserves further examination and study. Because of this, treatment of data on rats as of one group does not appear logical. In addition, such data may possess a natural grouping in accordance with prenatal and lactation effects.

The presence of 125 ppm of fluorine as sodium fluoride in the food or water and the presence of 200 ppm of iodoacetic acid in the drinking water significantly reduced the production of caries in rats. It is implied by the authors that the prevention of rat caries by administration of fluorine may in itself be taken as evidence against the belief that a mechanical factor is the essential feature of this phenomenon. — V. D. C.

### **II. Effect of Subcutaneous Injection of Fluoride. F. A. Arnold, Jr. and F. J. McClure. *J. D. Res.* 20: 457, (October 1941).**

Rats weaned at 21-23 days of age and placed on a caries-producing cornmeal diet at slightly more than 30 days of age were used. Litter



mates were distributed among three groups: control, twenty-three rats; injection, twenty-four rats, and fluoride water, twenty rats. All groups were given food and water ad libitum. The control group and the injection group received distilled water, the third group, drinking water containing 10 ppm of fluorine as sodium fluoride. The injection group received subcutaneous injections of the solution of sodium fluoride equivalent in amount to the average daily fluorine intake of rats whose drinking water contained 40-50 ppm of fluorine. At the end of the experimental period, the caries incidence was estimated and the enamel and dentin of molar and incisor crowns from the right mandible and maxilla were analyzed for fluorine content.

Subcutaneous injection of sodium fluoride was found to have produced no significant reduction in caries incidence. The fluorine content of the enamel and dentin of incisor and erupted molar teeth was increased both by subcutaneous injection of sodium fluoride and by giving water containing 10 ppm of fluorine. The observations on injected rats would seem to rule out any systemic influence of fluorine on induced rat caries when the fluorine is introduced during the posteruptive tooth period. These results indicate that although the fluorine content of the molar teeth of rats injected with sodium fluoride was increased, these teeth did not show increased resistance to caries. — J. T. G.

### **III. Effect of Fluoride On Rat Caries And On Composition of Rats Teeth. F. J. McClure. *J. Nutrition*. 22: 391, (October 1941).**

Groups of rats aged 23-25 days from sixteen to twenty-three litter mates as controls and corresponding test groups were fed a caries-producing cornmeal diet for a period of fifteen weeks. Fluorine was added in all test groups except two, via the drinking water, in concentrations of 5, 10, 50 and 100 ppm. In these cases, it was administered as 125 ppm in the food and as 10 parts subcutaneously.

A minimum of 10 ppm of fluorine in drinking water gave partial protection against occlusal rat caries. Approximately 80 per cent protection resulted from both 50 and 100 ppm fluorine in water. It is suggested that fluorine acts to inhibit rat caries by anti-enzymatic local action within the oral cavity.

The pooled molar teeth of groups of carious rats were not different from those of non-carious rats in content of ash, calcium and phosphorus and in fluorine which was deposited after tooth eruption. The post-eruptive addition of fluorine to the molar teeth of rats occurred in relatively large quantities and is regarded as occurring independently of oral enamel surface adsorption of fluoride. A significant effect of fluoride ingestion after tooth eruption on induced rat caries was not evident. — J. E. G.

### **IV. Inhibiting Effect of Fluoride Ingested Posteruptively And Prior To The Caries Producing Diet. F. J. McClure. *J. D. Res.* (Feb. 1943).**

Rats aged 40, 100 and 200 days were given fluoride prior to being placed on a caries-producing diet. The results indicate that this pre-fluoride period brought about an appreciable resistance to rat caries, particularly in the youngest rats. Fluoride was found to have increased notably in the dentin and enamel of the rats' teeth, the effect apparently being due to incorporation of fluoride in the adult tooth. In the light of these results, it seems reasonable to expect that should the adult human

tooth be made to acquire fluorine similarly, as a secondary deposit, it might thereby be partially protected against dental caries.

**Reduction In Experimental Rat Caries By Fluorine.**  
S. B. Finn and H. C. Hodge. *J. Nutrition.* **22:** 255, (Sept. 1941.)

One hundred and thirty-five rats (Wistar strain) were divided into three groups at weaning. The first group received the Hoppert, Webber and Canniff caries-producing diet; the second group received the same diet with the substitution of commercial casein for the powdered whole milk; the third group received the latter diet with the addition of 3 mg. (about 300 ppm) of fluorine (as potassium fluoride) daily. Each group was subdivided into three groups receiving respectively (a) cracked corn particles larger than 20 mesh only; (b) corn particles between 10 and 20 mesh, and (c) unsifted run-of-the-mill cracked corn. Rickets appearing in the rats receiving casein was promptly healed by incorporation of 2 per cent whole yeast and 2 per cent cod liver oil in the diets. Duration of feeding was 200 days. There was a high, statistically significant reduction in the average number of cavities, cusps involved and teeth lost per rat in the fluorine-fed group. Varying the size of the cracked corn had no significant effect on the caries incidence. (All the diets contained corn particles at least as large as 10 to 20 mesh; i. e., coarse corn particles.) There is evidence that fluorine limits caries progress as well as reduces the incidence of lesions. The mechanism of the inhibiting or protective action of fluorine is unknown. — J. E. G.

**Effect of Topical Fluorine Application On Experimental Rat Caries.** R. F. Sognaes. *Brit. D. J.* **70:** 433, (June 16, 1941).

Thirty normal rats were placed on a coarse-corn, caries-producing diet at 50 days of age. Sixteen rats received a local application of fluorine. Ten of these rats were treated during the first days of the experimental period and subsequently at intervals of two weeks. Six rats were treated with fluorine only during the middle and latter part of the experimental period. It was found that the number of teeth affected by caries, per animal, was twice as high in the control group as in the group that received topical applications of fluorine from the beginning of the experiment. In the group that received fluorine only in the middle and latter part of the experimental period, the difference was less apparent. An apparatus designed by the author facilitated the topical application of fluorine to the teeth. — J. T. G.

**Effect of Dietary Fluorine In Delaying Dental Caries.**  
J. F. McClendon and W. C. Foster. *J. D. Res.* **21:** 139, (April 1942).

Evidence collected for twenty years indicates that fluorine is beneficial to the teeth, whereas the majority of workers have been interested in discovering the deleterious effects of fluorine. This is the first investigation in which the fluorine content of the diet was determined (0.3 parts per million). Addition of teeth or tooth salts to a cracked cereal diet containing 0.3 ppm of fluorine slightly delayed dental caries in rats. The addition of 9 or 10 parts per million of fluorine as fluoride to the



drinking water delayed caries further (from forty days to one hundred and sixty days) and increased the fluorine content of dentin six times and enamel three times.

**Fluorides In Food And Drinking Water. F. J. McClure.**  
*Nat. Inst. Health, Bul. No. 172 (39).*

Following essential information presented in author's approach, materially helps to better understanding of general fluorosis problem and conclusions based on his experiments. Human fluorosis, or mottled enamel, is restricted to areas where domestic water contains toxic quantities of fluorides (F's). Limited to endemic hypoplasia of permanent teeth. In severe cases, brown stain is a secondary complication. Importance of food as F vector is largely unknown. In general, F-containing foods do not constitute an appreciable portion of infants and childrens diet but, when they do, mottled enamel may occur only if certain minute quantities of F are ingested regularly during development of crowns, except 3rd molars, from birth to 8 years. Ultimate effects of F-containing food and water depend on total of both consumed regularly. Possible that natural F-content of food may not be as toxic as inorganic F compounds per se or in water. Thus, mode of ingestion might differentiate between effects of food F's or water F's. Earlier experiments with rats indicated 500 ppm. NaF in drinking water produced relatively greater toxicity than same amount in diet. Differences in total F ingested, relative degree and rates of absorption, and other factors, however, condition these results. Other workers using different methods found little difference attributable to food versus water ingestion. Bones and teeth are main F depositories. Author's experimental plan was well organized and controlled. Careful consideration was given to the chemistry of F determination. Conclusions follow: With growing young rats as experimental animal, chronic fluorosis was studied particularly from standpoint of severity of effects produced by 22.6, 45.2 and 90.4 ppm equivalent of F ingested in food, compared with similar quantities ingested in drinking water. So far as may be shown by (1) average daily body gain, (2) ash and F content of bones and teeth, (3) appearance of teeth, and (4) total F retained in final body weight, no noticeable differences could be attributed to either of two mediums of F ingestion. Acute toxic effects of approximately 180 ppm. F as NaF in drinking water was noted, confirming previous observations. These, however, are not to be confused with conditions and effects accompanying F consumption in drinking waters of mottled enamel areas. Average total retention of F from NaF may equal 30 to 40 per cent of intake, at concentrations studied. By far, greater portion of this F is deposited in bones and teeth. Degree of tooth hypoplasia in rat is directly correlated with quantity of F present. Has been suggested that F content of bones and teeth of experiment animals may be developed into biologic test for effective F's in foods as well as a means of indicating pathologic condition in affected tissue. In young rats: (1) there is a suggested stimulating effect of 22.6 ppm F in diet, on appetite and perhaps on daily body gain; (2) stimulating effects of F's on water-drinking again noted; (3) NaF equivalent to 45 ppm or more F in food and water indicated reduced rate of gain; (4) increased ash content of bones occurred from NaF ingestion equaling 226 to 600 ppm. F. In rat, 0.03-0.04 per cent F represents approximate maximum that may be present in whole tooth and tooth-enamel still retain normal microscopic appearance. Quantities of F in large number of foods, as reported in literature are summarized. Although extremely difficult to judge actual conditions of ingestion, and while positive statements are not warranted, would appear that accumulation of F in bones of adults living in areas where mottled enamel

is endemic may be expected. Accumulation of abnormal and perhaps pathologic quantities of F in bones of adults in such areas appears probable. Future study of chronic fluorosis requires placement of emphasis on localization of F, particularly in bones and teeth, relating directly to cumulative effects of F ingested. More information is needed relative to quantities of F's in foods, toxicity of natural food F's, as compared with pure inorganic F's associative factors involved in F absorption and metabolism. Direct information is needed from epidemiological biochemical studies relative to involvement particularly of bone tissue among human populations of mottled enamel areas. 4 graphs, 6 tables, 27 photographs and 89 refs. — R. E. N.

**Vitamin D And Fluorine.** B. R. East. *Am. J. Dis. Child.*, **64**: 867, (Nov. 1942).

It has been shown that resistance of children to dental caries is increased when they are fed certain specified amounts of vitamin D and that improving the diet as a whole also leads to greater resistance to the disease. The principal source of vitamin D, as supplied naturally, is the action of solar ultraviolet energy on the steroids in the bodies of men and animals. The principal factor in the intensity of solar energy is the latitude of the place where the exposure occurs, while the time of exposure is related to the number of hours of sunshine prevailing, i. e., the number of clear and cloudy days. Epidemiologic studies indicate that a negative relationship exists between many hours of sunshine, low altitudes and high caries rates.

The fluorine content of communal water supplies seems to be definitely related to resistance to caries in children. The greater the amount of fluorine, with optimum limits, the greater the resistance.

When the location of areas "where mottled enamel has been demonstrated by surveys and/or recorded in the literature" and the areas "where endemic mottled enamel has been reported but not verified" are compared with areas of a United States Weather Bureau Sunshine Map, certain facts are noted. A great number of the reported fluorine areas are located where higher amounts of vitamin D-producing sunshine prevail. A great number of the reported fluorine areas are located in the lower latitudes. Two of the northern areas where fluorine has been reported, the Dakotas and Iowas, enjoy climatic conditions that are particularly effective in distributing ultraviolet energy for cutaneous exposures during the winter months.

If the synergistic relationship between fluorine and vitamin D intake observed in animals holds true for children also, it appears that the geographic distribution of fluorine and solar vitamin D-producing energy is favorable to it. — J. E. G.

**Prevention of Dental Caries By Brushing The Teeth With Fluorapatite.** J. F. McClendon and W. C. Foster. *Federation Proc.*, **2**: 34 (March 1943).

Rats on a caries-producing diet containing 0.3 ppm of fluorine developed 3.3 cavities per rat in ninety days; while rats on the same diet having their teeth brushed every day with powdered fluorapatite developed 0.3 cavities per rat. In 100 days, the figures were 3.5 and 0.5 cavities per rat, respectively. The dentin in the molars of the brushed teeth contained eleven times as much fluorine as that in the unbrushed teeth. The increase in fluorine in the enamel was about five times. The



more rapid growth and greater health of the rats that had the teeth brushed with fluorapatite indicated that some fluorapatite was swallowed. — D. B. S.

**Studies On Masticatory Efficiency: Part 3: Muscle Strength of Normal and Fluorosed Rats.** R. F Sognnaes. *Am. J. Orthodontics*. **27**: 458, (Aug. 1941).

It has been suggested by many investigators that the mechanical force of mastication is an important factor in rat caries produced by coarsely ground diets. Incorporation of fluorine in these diets is known to reduce the caries lesions. Such a condition might result from the action of fluorine on the muscle function. This possibility was examined by measurements of the muscle strength of fluorosed and normal rats. No remarkable difference was found. The results seem to exclude the possibility that the inhibitory effect of fluorine in rat caries is due to any decrease in muscle strength and masticatory force. — F. B.

**Inverse Ratio Between Fluoride In Food And Drink And Dental Caries.** J. F. McClendon, W. C. Foster and G. C. Supple. *Arch. Biochem*, **1**: 51, (Oct. 1942).

Milk from localities involved in dental caries studies reported by the U. S. Public Health Service was analyzed for fluoride. The incidence of dental caries in city school children from 12 to 14 years of age varied inversely with the fluoride content of the milk supply. The correlation coefficient of caries to fluorine was 0.37. — P. P. D.

**Milk As a Preventive of Mottled Enamel of The Teeth.** James A. Tobey. *Milk Plant Monthly*, **26**: 1; 30 (37).

Presence of fluorine in drinking water and absence of adequate content of calcium in diet are the factors concerned with mottled tooth enamel. Fluorine, to extent of 2-5 ppm, in drinking water will cause defective enamel in children's teeth. Recommended that where such waters exist milk be substituted for it; this will also supply adequate calcium. Fluorine content of milk is very low even when cattle receive substantial amounts in their drinking water. — R. E. T.

## CHEMISTRY STUDIES

**The Action of Fluorine In Limiting Dental Caries.**  
J. F. Volker and B. G. Bibby. *Medicine*, **20**: 211, (May 1941).

Recent researches into the relationship between fluorine and dental caries point to the conclusion that a direct limiting influence exists independently of the production of mottling of enamel. Evidence of this influence on caries is presented from field studies by authoritative investigators throughout the world. From chemical analysis of carious and non-carious enamel and from observations made on the caries susceptibility of rats fed a coarse particle diet, the fact that the ingestion of fluorine can limit susceptibility to dental decay is established, and it leads to a practical method of caries prevention. However, the method of action of fluorine must be determined.

Assuming that the initial lesion of tooth decay is decalcification of the surface enamel by acid products of bacterial fermentation, three possible conditions may be influenced by the presence of fluorine: salivary action, acid formation and tooth resistance. Field studies and animal experiments reveal the relative unimportance of the saliva. Since the enzymatic activity of the saliva may be considered the first step in bacterial acid production, and since this activity is practically unaffected by fluorine of from 0.76 to 760 ppm (McClure), there is little or no immunizing effect. Further, findings in connection with the reduction of oral bacteria or interference with their activities by fluorine are inconclusive when applied to the human mouth. However, a definite reduction in acid formation of fluorosed teeth observed may be explained by fluorine combination with or absorption by the tooth itself. There is evidence that the presence of fluorine in the drinking water, while in contact with the enamel on being taken into the mouth, serves to increase tooth resistance by combining with the surface enamel. The use of dentrifices and mouth washes containing fluorine of about five ppm is suggested for extensive trial under well-controlled clinical conditions. — H. B. McC.

**Possible Relationship Between The Fluorine Content of Enamel And Resistance To Dental Caries.** W. D. Armstrong and P. J. Brekhuis. *J. D. Res*, **17**: 393, (Oct. 1939).

Data indicate the marked difference in the fluorine content of the enamel of sound and carious teeth of the same individual.

Further data, the results of 26 consecutive analyses show that a low fluorine content is a characteristic of carious teeth in general.

The difference in the mean fluorine contents of the enamel of sound and carious teeth is 11.9 times its standard error.

There is no significant difference, however, in the fluorine content of the dentin of sound and carious teeth.

The mean fluorine content of the enamel of sound and carious teeth has been found to be 0.0111 and 0.0069 per cent respectively. — J. T. F.



**Storage of Fluorine In Human Bones And Teeth.** J. F. McClendon and W. C. Foster. *Federation Proc.*, **2**: 33, (March 1943).

On an ordinary diet, two subjects excreted 1 mg. of fluorine per day in the urine. The dentin of two molars removed from one subject contained 0.019 and 0.033 per cent respectively. For a period of about one year, the subjects ingested 1 gm. of powdered fluorapatite containing 40 mg. of fluorine daily. During this period, two more molars were removed from the same subject. The dentin contained 0.047 per cent fluorine respectively. The urinary output of fluorine remained constant during the period of the experiment at levels varying between 8.4 and 11 mg. daily. The results indicate that since the amount of fluorine retained after ingestion is more than could be stored in the teeth, it is stored in the bones. — D. B. S.

**On The Manner of Acquisition of Fluorine By Mature Teeth.** M. W. Perry and W. D. Armstrong. *J. Nutrition*, **21**: 35 (Jan. 1941).

Male albino rats that had been raised to maturity on the same stock diet were given a measured diet and water intake over a sixty-day period, the water supplied to the experimental group containing 20 ppm of fluorine. After five days on only distilled water, the animals were killed and the teeth obtained for the study. The molars and incisors were pooled in separate lots and the enamel and dentin removed for analysis. The molars were found to contain more fluorine in the dentin than in the enamel, but the reverse was true with respect to the incisor teeth. Furthermore, when the animals were given water containing 20 ppm of fluorine, it was found that the fluorine content of the dentin of molar teeth of mature rats was not increased. From these facts, it is concluded that a secondary enrichment of dentin with fluorine occurs after its calcification, and that the process does not continue indefinitely. The fluorine content of the enamel of mature erupted rat molars is increased by the fluorine entering the surface when the animals are given drinking water containing 20 ppm of the element. — J. S.

**Absorption And Excretion of Fluorides: Part 1. The Normal Fluoride Balance.** W. Machle, E. W. Scott and E. J. Sargent. *J. Indust. Hyg. and Toxicol.* **24**: 199, (Sept. 1941).

A normal experimental adult subject on a normal diet maintained an equilibrium between intake and output of fluorides indicating that an accumulation of fluoride in the skeleton does not occur at intake levels of 0.5 to 1.5 mg. per day. Eighty per cent of the ingested fluoride was absorbed and all of the absorbed fluoride was lost by excretion. No roentgenologic changes or alterations in the state of health that could be attributed to ingestion of this amount of fluoride were noted. The ingestion of water containing as little as 1 ppm of fluorine is known to produce mottling of enamel. It is apparent that if the daily consumption of water containing 1 ppm of fluoride is approximately 2 liters, a normal person would ingest about 2 mg. of fluoride per day, 80 per cent of which would be absorbed. The varying activity of such a small amount of fluorine can possibly be explained by the effect of calcification processes on fluorine retention in the bones and teeth of growing children. — R. H.

**Observations On The Adsorption of Fluoride By The Enamel.** J. F. Volker. *J. D. Res.* **22**: 201, (June 1943).

Enamel treated with 8 ppm of NaF and  $\text{DaF}_2$  shows a significant reduction in acid solubility. The reaction takes place within a very limited time.

**Studies On The Distribution of Radioactive Fluoride In Bones And Teeth of Experimental Animals.** J. F. Volker, R. F. Sognnaes and B. G. Bibby. *Am. J. Physiol.* **132**: 707, (April 1941).

Radioactive fluoride was given by intraperitoneal injection to five rats and by intravenous injection to four cats. Concentrations of the blood fluoride fell rapidly with a corresponding rise in the calcified tissue fluoride. The radioactive fluoride concentration of the various skeletal tissues was approximately directly proportional to their proximity to the circulating blood. Urinary excretion and salivary secretion of the isotope occurred in appreciable amounts only when the blood concentration was elevated.—J. F. V.

**Secretion of Intravenously Injected Fluorine In The Submaxillary Saliva of Cats.** J. H. Wills. *J. D. Res.* **19**: 585, (Dec. 1940).

The purpose of this paper was to investigate the passage of fluorine and chlorine from the blood to the saliva. It was found that radioactive fluorine injected intravenously into cats appeared in the saliva in significant quantity within one minute. An average of 0.082 per cent of the fluorine entered the saliva during the twenty-one minutes following the injection, and an average of 0.365 per cent of the radioactive chlorine was excreted in the saliva within twenty-three minutes. In resting cats, the gland being stimulated fifty minutes after the injection of the fluorine, an average of 0.020 per cent of the fluorine was excreted in the saliva during the twenty-one minutes following the beginning of stimulation. It was found that the ratio of fluorine in saliva to that in plasma was on the average 0.098 and similar ratio for chlorine was 0.389.—J. T. G.

**Effects of Fluorides On Salivary Amylase.** F. J. McClure. *Pub. Hlth. Rep.* **54**: 2165, (Dec. 8. 1939).

The fluorides NaF,  $\text{NH}_4\text{F}$  and  $\text{Na}_2\text{SiF}_6$  were found to have no effect on the activity of salivary amylase in concentrations varying from 1.7 to 8,550 ppm of fluorine present in 1 to 10 dilutions of salivas which stood for one hour in the cold prior to testing amylolytic property. The same fluorides, when present in the enzyme-substrate mixture during the digestion period in concentrations varying from 0.76 to 760 ppm of fluorine in the substrate had no final effect on enzyme activity.

The salivas of school children whose drinking water contained an average of 1.8 ppm of fluorine showed no differences in amylolytic action from a similar group of salivas obtained under similar conditions from school children whose drinking water was free from fluoride.



**The Effect of Fluorine On Mouth Bacteria.** B. G. Bibby and M. VanKesterem. *J. D. Res.* **19**: 391, (Aug. 1940).

The effects of various concentrations of sodium fluoride solutions on the growth and acid production of streptococci, lactobacilli, and other mouth organisms were tested. The action of fluorosed and fluorine-treated dental tissues were similarly studied.

Fluorine concentrations of less than 1 ppm limit acid production by bacteria but concentrations in excess of 250 ppm are needed to effect bacterial growth.

Fluorosed and fluorine treated enamel and dentine also reduce acid production by bacterial cultures.

**Ingestion of Fluorides And Dental Caries.** J. J. McClure. *J. Dis. Child.* **66**: 362, (Oct. 1943).

Charts are given which estimate the daily intake of fluorine from water and food in certain concentrations for children in the age ranges 1 to 12 years. Estimates that the average child using water which contains 1 ppm of fluorine will ingest from 5 to 1 mg. of fluorine daily.

The average child will ingest about .45 mg. of fluorine from food daily. The quantity of water-borne fluorine plus fluorine contained in foods may bring the total amount of fluorine contained in the average daily diet up to 1 to 1.50 mg. The ratio of these approximate levels of intake to body weight would probably rarely exceed 0.1 mg. per kg. of body weight. As a general rule, this average would equal about 0.05 mg. daily per kg. of weight for children of these age groups. — J. T. F.

**Fluorides In Food And Drinking Water.** F. J. McClure. *Nat. Inst. Health Bul. No.* **172**.

Standard of total water intake for any mammal is 1 c. c. of water per calorie of heat produced.

For children, daily requirement about 3400 c. c.

2000 c. c. of water contained in food.

1500 c. c. containing 2 to 3 ppm of fluorine will provide 2.4 to 4.5 m. g. in daily intake.

If 40 per cent is retained 0.7 to 1.8 mg. of fluorine is retained daily.

In 60 years 15.3 to 39.4 gmm would be deposited in the body or at a weight of 150 pounds a concentration of 225 to 580 mg. per kg. of body weight.

Roholm is quoted as estimating the pathologic osseous system of one deceased cryolite worker to contain a total of 90 gm. of fluorine at autopsy. Roughly 1440 mg. of fluorine per kg. of body weight. — J. T. F.

**Effect of Certain Mineral Compounds On The Toxicity of Calcium Fluoride.** A. Charnot. *Bull. Acad. Med.* **120**: 224 ('38).

The careful investigations of the French scientists into the somewhat puzzling divergencies in the symptoms of the toxicity due to presence of fluoride in food have produced an explanation. The diversity of the lesions known under the collective title of "darmous" have been analyzed in the ash of experimental animals. These investigations explain the different manifestations reported from time to time as to the variety of the effects of the toxicity of calcium fluoride. The affinity of

fluorine for certain simple or compound substances, its prevalence in nature and its association with certain chemical compounds and groups and its cohesion to them seems to point to its biological action being dependent upon these associations. In darmous its association with tri-basic phosphate seems to indicate that it plays the part of a mordant. The salts of aluminum when present in food diminish the toxicity of calcium fluoride in natural phosphates and release the phosphates as beneficial elements. The presence of silica on the other hand produces a fragility of the bones. Calcium fluoride associated with these salts manifests itself by modifications in the concentration of different elements found in the ash. The amount of silica is diminished in the absence of salts of aluminum in the food or when free mineral acids are present in excess, but is augmented by organic acids. Silica fixes fluorine, aluminum diminishes the amount of fixed fluorine except in the presence of silica. The amount of calcium in the ash is increased when calcium fluoride has been added, especially in the presence of phosphoric acid. The result of presence of these elements in food can be tested by radio-graphy as well as by the ash. The toxic effect of calcium fluoride can be detected by X-rays in a generalized hypercalcification more pronounced in the long bones, maxillae, cranium, vertebrae. The toxic effect of the natural phosphates is much the same as that caused by absorption of equivalent quantities of tricalcic phosphate and calcium fluoride. The bones do not increase in thickness but in density as seen by the increased density in the X-rays. In presence of calcium fluoride the salts of aluminum, notably those of mineral acids, diminish the density of bone. When calcium fluoride is present in the food and other minerals are in excess, various organs are affected in various ways: (1) when mineral acids are present there is sclerosis of the spleen; (2) salts of sodium in excess lead to fatty degeneration of the kidneys; (3) salts of calcium or aluminum (particularly those of the mineral acids) lead to ossified islands in the medullary cavity and a condensation of the bone; (4) silica or silicates lead to ossification and an almost complete obliteration of the medullary canal. These investigations explain the different manifestations reported from time to time as to the variety of the effects of the toxicity of calcium fluoride. — B. H.

**Histologic Study On The Effects of Fluorine Administered In Dry And Moist Diets On The Teeth of Young Albino Rats.** M. M. Hoffman, C. Schuck and W. J. Furuta. *J. D. Res.* **21**: 157, (April 1942).

Thirty-three albino rats were weaned at 21-24 days of age and were placed on fluorine-containing diets. The pigment and gross and histologic changes in the incisors and molars showed that the animals which received the fluorine in water (0.05 per cent sodium fluoride) were most severely affected; those that received it in milk, next, and those receiving it in dry diet, the least. Histologic changes in all experimental groups were as follows: (1) degeneration of ameloblasts with enamel hypoplasia and cystic formations, (2) accentuation of incremental lines in enamel and dentin with rate of incrementation remaining normal (approximately 16 microns), (3) rachitic-like changes in the dentin of incisor and molar teeth (interglobular dentin); (4) occurrence of excessive osteoid tissue in alveolar bone; (5) retarded eruption of third molars, and (6) persistence of organic enamel matrix in incisors and third molars, possibly associated with poor mineralization. Findings indicate that crystallization of mineral salts in enamel may be en masse and probably occurs at the cessation of the functional morphologic and



chemical differentiation of the organic matrix. Findings also suggest disturbances in the physiologic economy of calcium-phosphorus metabolism in the presence of fluorine despite adequate mineral intake.

**A Comparison of Sodium Fluoride In The Drinking Water With Similar Levels of Cryolite In The Diet On The Fluorine Content of The Body.** S. Marcovitch and W. W. Stanley. *J. Nutrition.* 16: 173, ('38).

Authors studied the fluorine retention in the bodies of rats when fluorine was taken in the drinking water and when the same level was given as synthetic cryolite ( $\text{?AlF}_3 \cdot 3\text{NaF}$ ) finely divided in the food. The animals were analyzed for fluorine content at birth, at 29 days and at 90 days, the entire body being used (except the stomach and intestines in the 90 day rats). The fluorine content at birth averaged 4.36 parts per million and was the same at 29 days. At the end of 90 days 2.09 ppm were present in the control rats. Those rats given 4 ppm of cryolite in the diet (beginning on the 29th day) showed 7.07 ppm at 90 days. When the same amount of fluorine was given as NaF in the drinking water, a figure of 13.02 ppm of body fluorine was found, that is, the body stores fluorine twice as fast when it is obtained in the drinking water. Striations in the teeth are produced by this amount in water but not by the same amount in food. Female rats showed a significantly greater proportion of fluorine in their bodies than did males when given fluorine additions to the diet or drink. — B. H.

**Calcium Intake And Fluorine Poisoning In Rats.** S. Ranganathan. *Indian J. M. Res.* 29: 693, (Oct. 1941).

Of eleven groups of six young growing albino rats each, some were placed upon diets containing levels of calcium varying from less than 0.1 per cent to 0.7 per cent. Sodium fluoride was added to these diets to the amount of 0.05 per cent. Other groups received a constant low calcium intake (0.1 per cent), while the dose of fluoride was varied. In two series, natural foodstuffs were substituted in place of calcium salts. The survival time and the weight changes of the animals during the experimental period of either 280 or 336 days were the criteria of toxicity.

Fluorine was highly toxic when the dietary intake of calcium was low or insufficient for the body needs of the animals. The addition of increasing doses of calcium salts to the diets containing a constant percentage of fluorine correspondingly increased the survival period of the animals. Calcium administered in natural foodstuffs likewise exerted a mitigating effect. Progressively decreasing doses of fluorine with a diet low in calcium proportionately increased the survival rate. — J. E. G.

**Production of Graded Mottling In Molar Teeth of Rats By Feeding of Potassium Fluoride.** V. D. Cheyne. *J. D. Res.* 21: 145, (April 1942).

The author presents a method for the production of graded mottling in the enamel of rat molars by the use of potassium fluoride fed soon after birth and during the period of appositional growth and calcification of the permanent teeth. Observations were made upon forty-three

Wistar strain animals. The formation period of the permanent dentition in the life of the rat is reviewed. Mild mottling was produced by doses as low as 150 ppm with extreme chance noted at 550 ppm. The optimum amount for moderate mottling was 300 ppm. Sex did not influence the susceptibility of the teeth to fluorine. Dental caries can be produced in the molar teeth of rats. Therefore, and because mottled teeth are known to contain considerable amounts of fluorine, the study offers a valuable approach to an understanding of the mechanism of fluorine action in preventing dental caries.

**Darmous: Effect of Phosphatic Soil In Chronic Fluorosis.** Gaud and A. Charnot. *Bull. Office Internat. d'hyg. Pub.* **30:** 1280, ('38).

Authors recount experiments of Velu on sheep affected by this disease known by natives in North Africa as "darmous." This is not altogether comparable to condition described in this country and above all in the United States as Mottled Teeth which, it has been proved, is occasioned by excess of fluorides in the water supply. Velu found that he could produce this condition in sheep by giving them water to drink which contained natural phosphates and he was puzzled by the observation that animals in one district were exempt from the darmous while those drinking the water in another place were affected. Gaud and Charnot examined these reports and made some experiments, with same result. They were perplexed by finding that the amount of fluoride in the water was not an appreciable percentage and they came to conclusion that the severity of the lesions must be due to the vegetation which grew on the affected soil. They also concluded that the phosphatic soil was deeper in some areas than others and that where the surface was hard and dense the herbage was not affected, but that when the surface was thin and light the wind blew the dust on to the leaves and in this way the animals became intoxicated more from the dust than from the water. Intoxication periods are intermittent, disappearing during the rainy and reappearing during the dry seasons. — W. P. R.

**Studies Relating To The Toxicity of Fluorine Compounds.** Kempf, C. A., D. A. Greenwood and V. E. Nelson. *J. Lab. Clin. M.* **22:** 1133, (Aug. 1937).

Experiments on dogs:

1. Oral administration of from 0.45 to 4.52 mg. of sodium fluoride per kilogram of body weight caused no effect on total calcium acid-soluble inorganic phosphorus, hemoglobin or coagulation time of the blood.
2. No changes in the bones on 4.52 mg. per kilogram of weight.
3. Ingestion of aluminum fluoride does not mottle the teeth.
4. The ingestion of aluminum sulphate, simultaneously with fluorides markedly reduces the effects of fluorine on the teeth.

**Toxicity of Fluorine In Dicalcium Phosphate.** F. DeEds. *Am. J. M. Sc.* **203:** 687, (May 1942).

The toxicity of fluorine present in dicalcium phosphate was investigated with the bleaching of rat incisor teeth as a criterion of injurious action. The sixteen specimens studied had all been prepared before



July 1939. The fluorine content ranged from 11 to 498 ppm, while nine samples ranged from 30 to 66 ppm. It was found that the fluorine present in dicalcium phosphate was as physiologically active as fluorine administered as sodium fluoride. An average daily dose of 1 teaspoonful of the phosphate contains 0.27 per cent fluorine, which represents an intake ten times as great as that said to produce mottled enamel in at least certain children. It is possible that the beneficial dental results reported as due to the administration of dicalcium phosphate may be due to the fluorine contaminant. — D. S. K. D.

**The Comparative Toxicity of Fluorine In Calcium Fluoride And In Cryolite.** M. Lawrenz, H. H. Mitchell and W. A. Ruth. *J. Nutrition*. **18**: 115, (Aug. 1939).

Rat feeding experiment. Over 96 per cent of the fluorine retained was deposited in the skeleton. 1.85 per cent in the teeth, 2.05 per cent in soft tissues. — J. T. F.

## TOXICOSIS

**Fluorine Intoxication.** K. Roholm. London, H. K. Lewis, (1937).

"The effect of fluorine depends upon the dose, the duration of ingestion, the age of the individual, the species, the composition of the diet and probably upon other circumstances as yet unknown."

"The known spontaneous chronic fluorine intoxications comprise the following diseases:

1. Mottled teeth, an affection of the teeth, which is endemic in man in certain parts of Europe, America, Africa and Asia.
2. Osteosclerosis, an occupational disease among cryolite workers in Copenhagen.
3. A disease like osteomalacia, endemic among herbivora in the environs of certain factories in Europe.
4. Darmous, a dental and mandible disease among herbivora in certain parts of North Africa.
5. Gaddur, a dental and bone disease among herbivora in Iceland after volcanic eruptions."

"The osteosclerosis is characterized by an increased endosteal and periosteal bone formation, with thickening of the cristae and processes, narrowing of the medullary cavity and more or less obliteration of the structure of the spongiosa. The disease, which has been observed only in adult individuals, principally attacks the cancellated bones. Side by side with the osteosclerosis, there is widespread calcification of the osseous ligaments."

"The bone changes must be regarded as reparable, for in time the sclerotic osseous tissue is replaced by normal tissue when the fluorine ingestion ceases".

**Acute Sodium Fluoride Poisoning.** W. L. Lidbeck, I. B. Hill and J. A. Beeman. *JAMA* 121: 826, (March 13, 1943).

The recent accidental ingestion of 17 pounds of sodium fluoride in a 10-gallon mixture of scrambled eggs at the Oregon State Hospital resulted in the highest morbidity and mortality reported from this poison. Of 263 cases, forty-seven terminated fatally. Analysis revealed that the eggs contained 3.2 to 13 per cent of sodium fluoride distributed spottily. Many patients rejected the food because of its salty or soapy taste. Those who accepted it complained of oral numbness. Severe nausea, vomiting and diarrhea occurred abruptly and at times simultaneously. Abdominal burning and cramplike pains appeared soon after the meal. General collapse developed in many victims at variable periods, apparently depending on the fluoride concentration. Collapse was characterized by pallor, weakness, absence or threadiness of the pulse, shallow unlabored respiration, weakness of the Heart tones, clamminess of the

skin, cyanosis and dilation of the pupils. With these symptoms, death almost invariably occurred. In cases in which death was delayed or recovery took place, paralysis of the muscles of deglutition, carpopedal spasm and spasm of the extremities were noted. Convulsions and abdominal rigidity or tenderness did not occur. In most cases, death took place between two and four hours after the meal, although in a few it was delayed for eighteen to twenty hours. The fatal dose of sodium fluoride is 5 to 10 gm. (Baldwin.) — P. P. D.

**Spondylosis Deformans In Relation To Fluorine And General Nutrition.** F. H. Kemp, M. Murray and D. D. Wilson. *Lancet*, 2: 93, (July 25, 1942).

A roentgenologic investigation was made of twenty-seven people (five adults and twenty-two children) to determine whether mottling of enamel due to fluorine ingestion was associated with skeletal changes. Findings suggested that disturbances of ossification were fairly common among children, but fluorine ingestion could not be held responsible, although two cases showing severe skeletal changes were associated with dental fluorosis, and six children from Maldon in Essex with markedly mottled enamel exhibited disturbance of ossification. Signs of similar developmental disturbances and early spondylosis deformans were found among many young adults, in some of whom dental fluorosis was also noted. The findings are in accord with clinical experience which suggests that spondylosis deformans is the result of progressive degeneration of malformation arising in youth. The presence of fluorine in the soil and water, in association with defective nutrition, may favor such maldevelopment. — P. P. D.

**Two Cases of Fluorine Osteosclerosis.** J. Wilkie. *Brit. J. Radiol.* 13: 213, (June 1940).

The bone changes are those of thickening of the bone lamina and an increase in the whiteness of the bone shadows on the X-ray to an actual opacity of the bones and calcification of the ligamentous attachments. Displacement of the bone marrow probably produced an anemia.

**Skeletal Sclerosis In Chronic Sodium Fluoride Poisoning.** P. D. Hodges et al. *JAMA* 117: 1938, (Dec. 6, 1941).

An attempt was made to demonstrate skeletal sclerosis in the inhabitants of two communities in central Illinois, where the drinking water contained 1.2 to 3 ppm of fluoride. Practically all of the subjects who had been exposed to the water during early childhood had typical mottled enamel. In no instance did carefully made roentgenograms show the occurrence of generalized skeletal sclerosis. 117 persons, ages from 7½ to 78 years were examined. Exposure to the fluorine water in some cases totaled 68 years. The authors conclude that the use of drinking water containing up to 3 ppm of sodium fluoride apparently does not cause radiologically demonstrable sclerosis of the skeleton even though the water is taken for a long period of time. — J. T. F.



**Fluoride Osteosclerosis From Drinking Water.** Linsman and McMurray. *Radiology*. **40**: 433, (May 1943).

Linsman and McMurray report a case of osteosclerosis with mottled enamel of teeth, severe anemia not responding to antianemic therapy, and bilateral renal lesions. Diagnosis of fluoride osteosclerosis was proved by the history of a long residence in areas of endemic fluorosis and by fluorine analysis of the patient's bones and teeth. Osteosclerosis may be a dangerous sequel to the chronic ingestion of fluorine-containing water since it may give rise to a secondary anemia due to encroachment on the blood-forming marrow. There is also the possibility of kidney damage due to chronic fluoremia. Areas in the United States in which dental fluorosis exists and where the fluorine content of the drinking water is over three ppm should be systematically studied by the public health authorities to determine the existence of osteosclerosis. All patients with dental fluorosis and anemia and/or signs of renal impairment should have x-ray examination of the skeletal system.

**Bone Changes In Endemic Fluorosis.** H. A. Mascheroni. J. M. Munoz and C. Reussi. *Rev. Soc. Argentina Biol.* **15**: 417 ('39).

Osteopetrosis observed in young woman who had lived all her life in district in which fluorine occurs in drinking waters in high concentrations. Post-mortem examinations confirmed radiographic diagnosis. Fluorine content of bone ash 0.975 per cent. — C. A.

**Chronic Fluorine Poisoning (Fluorosis) — Signs And Symptoms.** L. Spira. *Edinburgh M. J.* **49**: 707, (Nov. 1942).

Survey of a great number of men and women in Great Britain revealed that 21.9 per cent of those examined had mottled enamel. Interrogation of 1,099 individuals further showed that the following symptoms and signs coexisted with mottling of the teeth: constipation, in 49 per cent; paresthesia, in 34.5 per cent; furunculosis, in 29.5 per cent; urticaria or other dermatoses, in 29 per cent; dhobie itch, in 18.5 per cent; alopecia, in 28.8 per cent, and brittleness of the nails, in 16.8 per cent. Only 11.4 per cent exhibited none of these signs or symptoms. These findings appear to substantiate the claim that the ingestion of fluorine affects the parathyroid glands. — H. H. McC.

**A Comparison of The Toxicity of Fluorine In The Form of Cryolite Administered In Water And In Food.** M. Lorenz, H. H. Mitchell and W. A. Ruth. *J. Nutrition*, **18**: 127, (Aug. 1939).

Doses of fluorine in the food are retained to a lesser extent than equal doses of fluorine in the drinking water.

Doses of fluorine at low levels have no apparent effect on the rate of growth of animals.

Continued ingestion results in a smaller per cent of retention in the body.

One ppm of fluorine in water is the hygienic equivalent of from 2.4 to 4.8 ppm of fluorine in the total food. — J. T. F.

**Fluorine In The Etiology of Endemic Goiter.** D. C. Wilson. *Lancet*, 1: 240, (Feb. 15, 1941).

The author finds an association between areas where fluorine-containing rocks are present and the occurrence of hypothyroidism. Fifty-five of 378 children (5-14 years of age) in goitrous areas showed mottled enamel. None of 103 children in non-goitrous areas showed this condition. Distribution of goiter in Punjab corresponded to this, but this condition was absent in fishermen and fish eaters.

The author does not assert that fluorine ingestion is the only cause. — B. G. B.

**Mottled Nails: An Early Sign of Fluorosis.** L. Spira. *J. Hyg.* 43: 69, (Jan. 1943).

Mottled enamel is frequently associated with defective nails and hair. In contrast to mottled enamel, the nails regain normalcy when treatment against fluorosis is instituted and the affected outgrowing portion is removed. Conversely, if fluorosis recurs, the nails often repeat the signs of mottling. Consequently, mottling of the nails is a basis for tests for the presence of fluoride. Loss of luster, brittleness and opaqueness are signs of mottling the nails, which frequently become furrowed in transverse bands and tend to curl clawlike when allowed to grow beyond the finger tips. A considerable portion of the normal nail may be replaced with areas of dull, opaque chalky white specks, patches or bands. — E. G. J.

**Observations On The Durability of Mottled Teeth.** M. C. Smith and H. V. Smith. *Am. J. Pub. Health*, 30: 1050, (Sept. 1940).

The authors, by way of discouraging attempts at mass reduction of caries by the addition of fluorine, within certain limits of concentration, to the drinking water of communities (as suggested by Cox), point out that there is reason to believe that although mottled teeth are somewhat more resistant to caries, they are structurally weak; and when decay begins, the result is often disastrous. They point to a statistical survey of inhabitants of St. David, Arizona, where the water supply contains from 1.6 to 4.0 parts per million of fluorine. Although in the age group from 12 to 14 years, only 33 per cent of the children had caries, nearly 100 per cent had caries in the ages from 21 to 41. In addition, the severity of the result of caries is evident in the high percentage of all the age groups with extracted teeth. Of the persons from 24 to 41, 50 per cent had had all the teeth extracted and replaced by dentures (a percentage that would seem very high indeed). The authors assert that the tooth structure is so impaired as to crumble on attempts to place fillings, extraction becoming necessary. — N. S. S.

**Mottled Enamel In Oklahoma Panhandle And Its Possible Relations To Child Development.** Johnny A. Blue. *J. Okla. State Med. Assoc.* 31: 295 ('38).

Survey of water supply of Oklahoma panhandle showed wells in endemic area to be 132-330 feet deep and to contain 0.6-2.6 ppm F. Wells in non-endemic areas contained about 0.6 ppm. Shallow wells con-

tained about 1 ppm. Studies made on 400 school children: 10 per cent reported fractured bones, 15 per cent rickets and 43 per cent were more than 10 per cent under weight. Dental caries, gingivitis, and malocclusion rates were much higher than normal. — C. A.

**Occurrence of Fluorine In The Drinking Water of New Mexico And The Menace of Fluorine To Health.** John D. Clark and Edward H. Mann. *Univ. New Mexico. Bul. Chem. Ser. 2, No. 5* ('38).

Of 157 different samples examined for F, 35 contained more than 0.9 ppm, which is considered danger point. 22 additional communities had water supplies containing more than 0.8 ppm of F. Map is included giving location of high F water supplies. White mottled enamel in teeth is commonly encountered in New Mexico, believed that no bone injury results unless water contains at least 6 ppm. Physiological effects of F on animal system are reviewed. Methods suitable for F removal from domestic water supplies are being studied. Addition of bone ash followed by boiling the water and allowing ppt. to settle removes much of F and may be a useful method for home use. — C. A.



## PUBLICATIONS OF OTHER COUNTRIES

**Dental Fluorosis And Caries In London Children.** M. M. Murray and D. C. Wilson. *Lancet*, 1: 98, (Jan. 24, 1942).

Evidence obtained in an examination of 1,400 evacuated London school children suggested that moderate mottling of the teeth was associated with greater immunity to dental caries. All the children examined had good general nutrition. None showed abnormal enlargement of the thyroid gland. This evidence supports that of a similar less detailed study previously made upon 1,048 Somerset children.

Fluorine analyses of the three main sources of the London water supply were as follows:

|                          |          |
|--------------------------|----------|
| Filtered Thames .....    | 1.10 ppm |
| Filtered Lee .....       | 0.15 ppm |
| Filtered New River ..... | 0.32 ppm |

However, in a report from the Metropolitan Water Board for 1936, the highest figure among other subsidiary sources was 1.2 ppm. It is suggested that low levels of fluorine in water taken during tooth development can significantly lower the incidence of caries. — V. H. P.

**Fluorine And Dental Caries.** D. C. Wilson. *Lancet*, 1: 375, (March 22, 1941).

The author reports finding mottled enamel in various countries of England in relation to various fluorine containing earths. These include Cumberland, Derbyshire, Durham and Westmoreland (fluorspar), Somerset (limestone and lias clay); Cornwall (china stone); Bedford and Buckinghamshire (lower greensand), and Bedfordshire, Berkshire, Gloucestershire, Oxfordshire and Wiltshire (Oxford clay). The Westmoreland area included one where freedom from caries had been recorded. An association was noted between nutritional adequacy and extent of fluorosis. Those where nutrition was good showed mild mottling; whereas, in those with "sub-normal" nutrition, mottling was associated with pitting and attrition of the enamel. This confirmed previous observations in the Punjab.

A naked eye survey of 1,048 Somerset children showed that, in two groups, one with fluorosed and the other without fluorosed teeth, immunity to caries was associated with increased fluorine intake. — B. G. B.

**Incidence of Mottled Teeth.** L. Spina. *Lancet*, 1: 694, (May 30, 1942).

One of the signs of chronic fluorine poisoning (fluorosis) is mottling of teeth. An examination of 5,019 men and women showed definite mottling of the teeth in 21.9 per cent. In this survey, there were almost twice as many men as women examined, but the percent-

age of mottled teeth was practically the same in the two groups. It was also noted that the women were much more careful regarding oral hygiene than the men were. The distribution of mottled teeth is analyzed according to the countries from which those examined come. Of those living in the London area, 23 per cent were affected. The highest percentage (85) occurred in persons from Hertfordshire and Northampton. — V. H. P.

**Mottled Teeth In Great Britain.** L. Spira and M. D. Prague. *Brit. D. J.*, 73: 149, (Sept. 15, 1942).

An investigation regarding the incidence of mottled teeth in England revealed that 21.90 per cent of 5,019 people were afflicted. It was impractical to determine the source of water supply of the localities in which the peoples examined lived during their childhood. Had this been possible, the findings could have been restricted to those areas known to have more than 1 ppm in the water supply and therefore would have more significance than a statement of percentage based upon total population.

Charts presenting age and sex distribution of mottled teeth revealed that the incidence was highest in the 17 to 20 year age group. The incidence declined rapidly after the age of 40. The latter fact has little significance since many subjects have become edentulous at this age. It is stated that any large scale survey regarding the incidence of mottled teeth will help to prove that, in principle, there is no difference between the action of fluorine and that of any other poison. The extent of its toxicity depends above all on the quantity ingested and on the length of time during which it has been taken. — G. F.

**Endemic Fluorosis In Great Britain.** L. Spira. *Edinburgh M. J.* 50: 237, (May 1943).

Several new sources of toxic amounts of fluorine in drinking water have been found which seem to help to account for the increase in fluorosis in areas where soil and prefiltration water show a non-toxic fluorine content. Tests show that fluorine is absorbed from (1) the filter powder used in metal-filter water purification, (2) ingredients used in building concrete wells for storage of drinking water (clay, chalk, lime, cement), (3) certain iron pipes and iron storage tanks and (4) certain aluminum cooking utensils. — D. B. S.

**Chronic Endemic Fluorosis In Northern India.** C. D. Marshall Day. *Br. Dental J. (Br.)* 68: 409, ('40).

Numerous endemic areas exist throughout Northern India, fluorine concentration in well water varying from 1.2 to 6.4 ppm. Enamel mottling is almost universal in both young and adult residents, while incidence of carries is low. Deciduous teeth of children between 5 and 7 years were affected; this indicates that placenta is permeable to fluorine and that fluorine is probably present in mothers milk. — C. A.

**Endemic Fluorosis In South India.** C. G. Pandit. *Bull. Mens. Office Intern. Hyg. Publ. (Fr.)* **32:** 450, ('40)

High incidence of spotted enamel on teeth of children and of spinal rigidity in adults was correlated with presence of fluorides in unusually large proportions in drinking water. — C. A.

**Endemic Fluorosis In South India. A Study of Factors In The Production of Mottled Enamel In Children And Severe Bone Manifestations In Adults.** C. G. Pandit et al. *Indian J. M. Res.*, **28:** 533, (October 1940).

In a three-year study of the picture involved in the production of mottling of enamel in children and severe bone manifestations in adults as a result of ingestion of fluorides in drinking water in certain areas of south India, it was found that:

1. Mottled enamel was universally present in children where the drinking water contained 1 ppm or more of fluorine. The severity was proportional to the fluoride content.
2. Deciduous teeth were also affected in areas with a high fluoride content and severe type of mottling.
3. A certain area containing fluorite or fluorapatite as a constituent in its rocks showed the highest fluoride content in the drinking water (6 ppm) and severe chronic fluorosis with bone and joint manifestations occurred in this area.
4. More than fifteen years' residence in this area was necessary in the case of adults to elicit these symptoms.
5. Disparities were noted in areas where the fluoride content was identical.
6. The incidence and severity of the disease had a definite relationship to the economic and nutritional status of the communities.
7. Vitamin C deficiency especially was associated with a high incidence. — N. S. S.

**Endemic Fluorosis In The Madras Presidency.** H. E. Shortt, G. R. McRobert, T. W. Barnard and A. S. Mannadi Nayar. *Ind. J. Med. Res.*, **25:** 553, ('37).

Occurrence of this condition in Madras Presidency (India) has been recorded in preliminary paper by Shortt, Pandit and Raghavachari (cf. JAWWA 30:181. Jan. '37). Present account is more complete description based on careful investigation of 10 cases from affected area admitted to hospital for this specific purpose. Cases were chiefly in advanced stage of disease and description, therefore, applies more especially to individuals who have been subjected for periods of 40 years or more influence of drinking water containing comparatively large amounts of fluorine compounds. Systematic clinical description of cases is given followed by description (illustrated) of bony changes, as shown by radiology, which account for many of biochemical investigations of blood and urine. In addition, in preliminary field investigation, earlier manifestations of disease, particularly mottled tooth enamel in children, were studied. Search of literature has failed to reveal account of fluorine intoxication comparable to that here described, either in area affected or in severity. Mottled enamel among children, which has very high incidence in area, is especially characteristic, of



permanent but also occurs in deciduous teeth when fluorine content of water is especially high. Latter indicates that very prolonged exposure is not necessary to cause this defect, provided fluorine content is high. Usual course in permanent teeth is that enamel loses its glistening appearance and becomes dead white like chalk, in one of three forms: (1) horizontal banding, (2) more or less centrally placed areas or (3) irregular patches. If consumption of the water continues, whiteness is replaced by chocolate-colored markings occupying exactly same areas. All these appearances are best shown by central upper incisors but any or all of teeth may be affected. Tooth defects seem to be confined to these color effects and there appears to be intervals, few or no ill effects are exhibited. At about 30 years first symptoms of intoxication appear, evidenced by recurrent tingling sensation in limbs and over body in general. Pain and stiffness next appear, especially in lumbar region of spine but also involving dorsal and cervical regions. Stiffness increases until entire spine, including cervical region, appears to be one continuous column of bone, producing condition of "poker back," and there is stiffness of various joints. Bony skeleton of thorax is markedly affected and ribs become rigidly fixed at junction with spine. Breathing, as result, becomes entirely abdominal, while chest assumes barrel-shaped outline flattened anteriorly. By time this condition is reached, individual is between 30 and 40 years of age and later and final stages are imminent. Patient is finally completely bed-ridden, mental powers being unimpaired. Death, when it occurs, is usually due to some intercurrent disease. In 6 of cases fluorine content of urine was much above normal: in only 3 cases was fluorine demonstrated in blood. Bibliography of 63 references is appended. — R. E. T.

**Endemic Fluorosis In The Pretoria District.** T. Ockerse. *J. S. Afr. Med.* **15: 261**, ('41).

Endemic dental fluorosis occurs in many areas in South Africa. Concentrations of fluorine in drinking water vary from 0 to 36.67 ppm. Six cases of chronic fluorine intoxication occurring on farm in Springbok flats area of Pretoria district studies. Water for farm pumped from borehole 350 feet deep, which passes down through formations of limestone, dolerite, shale and calcite. Source of fluorine may be fluorapatite in dolerite or detrital apatite. Analysis of water from borehole showed that it contained 11.78 ppm fluorine. Teeth of children who had used water from borehole for drinking had mottled enamel. Mottled enamel also found on teeth of 4 cows reared on farm. Six natives who had used water from borehole since 1922 showed symptoms which, from clinical and radiological examinations, similar to those of chronic fluorine intoxication described by other investigators. — W. P. R.

**Effect of Fluorine On Dental Enamel And The Fluorine Content of Some Hungarian Potable Waters.** Janos Straub. *Orvosi Hetilap. (Hung.)* **84: 121**, ('40).

Of 80 samples of well water examined, 2 samples contained 858 and 809, and 11 more than 500 fluorine per liter. Water of Budapest aqueduct contained 186 fluorine per liter. Relation between fluorine content of waters and dental disorders cannot yet be proved in Hungary. — C. A.

**The Occurrence of Mottled Enamel of Teeth In Alberta And Its Relation To The Fluorine Content of The Water Supply.** Osman J. Walker and Elvins Y. Spencer. *Can. J. Research*, 15:B: 305, ('37).

In several parts of Alberta mottled enamel in mild form is endemic, especially in area surrounding Lethbridge and in area south of Red Deer. From examination of more than 250 samples of water from different parts of province, a relation was found between high fluorine content of water supply and prevalence of mottled enamel. — R. E. T.

**Dental Fluorosis In Mexico.** Luis Mazzotti and M. Gonzalez. *Riv. del Inst. de Salub. y Enferm. Trop. (Mex.)* 105: 1 (Nov. 1939).

Report of preliminary survey undertaken in cooperation with physicians of Public Health Department to determine extent of fluoride distribution in water supplies and to detect presence of dental fluorosis in Mexico of 107 samples analyzed, only 5 were fluoride-free. Concentrations upwards of 0.9 ppm were found in at least one sample from each of 11 states and 2 territories of 22 political subdivisions included in survey. In general, no modification in dental enamel was noted in areas where fluoride free water was used. Where concentration ranged from 0.1 to 0.4 ppm, difficult to detect signs of mottled enamel. Where concentration ranged from 0.5 to 0.9 ppm, a few cases of affected enamel were noted, especially as concentration approached 1 ppm. Waters with fluoride content exceeding 1 ppm associated practically always with mottled enamel production of varying degrees of severity. Highest fluoride concentration found was 17.5 ppm, there being waters from 4 other localities which contained from 4 to 7.5 ppm. Results of survey seem to indicate that dental fluorosis in Mexico resembles more closely "mottled enamel" of United States than "darmous" of Northern Africa. Since there are still many places where no survey made, presence of dental fluorosis in Mexico is probably much more extensive than progress report indicates. — J. M. S.

**Endemic Dental Fluorosis — Amount of Fluoride Allowable In Drinking Water.** Rogelio A. Trelles. *Bol. Obras Sanitarias Nacion (Buenos Aires)* 2: 367, (Oct. 1938).

Dental examination of three groups of children residing in areas where the fluoride content of the water was 0.6, 1.2 and 2.4 ppm and who during the first ten years of their lives have made constant use of these waters, indicated following results: Among 2,200 children examined in the 0.6 ppm F zone, not a single case of mottled enamel was found; of 231 children, in the 1.2 ppm F zone 53 per cent had normal teeth, 15 per cent were doubtful cases and 31 per cent showed slight to moderate mottling of the teeth; 27 per cent of the 180 examinations made in the 2.4 ppm F zone showed freedom from mottling 25 per cent were classified as doubtful, and 48 per cent were found with moderately severe to severe mottling. No cases of mottled temporary teeth were found in any of the three zones studied. Author is planning to conduct similar studies in other areas to determine effect of variations in mineral content of the water upon the toxicity of fluoroides. Experi-

ments with rats are also being carried on concurrently with these field studies in an attempt to obtain a means of forecasting the toxicity of the fluoride content of a water supply by observation of its effect upon the teeth of animals. — J. M. S.

**Dental Fluorosis And Drinking Water In The United States.** H. T. Dean. *Bull. Office Internat. d'Hyg. Pub.* 30: 1294, (1938).

Trendley Dean, arguing from a wide experience in the United States, suggests that differences noted in Morocco and those reported by him are such as can only be explained by means of quantitative studies carried out on the spot. The symptoms, such as pain on drinking cold water, sensitiveness on eating, have not been noted in the States and he accounts for the severe attrition by the grit which gets into the food, wearing away the enamel and exposing the sensitive part of the tooth. That the water is reported to contain but a minimal amount of fluoride is no criterion for the amount taken into the system, for in such a climate where the heat is intense much larger quantities of water would be imbibed than in other localities. — W. P. R.



TABULATION OF SPECIAL FLUORIDE DETERMINATIONS\* ON  
A FEW REPRESENTATIVE SAMPLES FROM WATER SUP-  
PLIES USED BY CONSIDERABLE NUMBERS OF PER-  
SONS IN VARIOUS SECTIONS OF CONNECTICUT

Collected during February, 1944

BY

BUREAU OF SANITARY ENGINEERING

(Including public surface water supplies and several deep wells)

| COUNTY     | CITY OR TOWN                 | SOURCES  | AMOUNT OF<br>FLUORIDES<br>P. P. M. |
|------------|------------------------------|--|------------------------------------|
| Fairfield  | Bridgeport                   | Public surface water supply<br>(Hemlocks Reservoir)  | 0.05                               |
| Fairfield  | Darien                       | Naval station drilled well<br>360 feet deep          | 0.05                               |
| Hartford   | Hartford                     | Public water supply<br>(Nepaug Reservoir)            | 0.0                                |
| Hartford   | Suffield                     | Village drilled well<br>190 feet deep                | 0.07                               |
| Litchfield | Norfolk                      | Public surface water supply<br>(Lake Wangum)         | 0.0                                |
| Litchfield | Litchfield<br>(Bantam)       | Housing Project<br>400 feet deep drilled well        | 0.1                                |
| Middlesex  | Middletown                   | Public surface water supply<br>(Mt. Higby Reservoir) | 0.0                                |
| Middlesex  | Middletown<br>(Newfield)     | School drilled well<br>130 feet deep                 | 0.0                                |
| New Haven  | Waterbury                    | Public surface water supply<br>(Wigwam Reservoir)    | 0.0                                |
| New Haven  | Bethany                      | Police barracks drilled well<br>200 feet deep        | 0.05                               |
| New London | New London                   | Public surface water supply<br>(Lake Konomoc)        | 0.0                                |
| New London | Norwich<br>(Occum)           | Village deep well<br>506 feet deep                   | 0.5                                |
| Tolland    | Rockville                    | Public water supply<br>(Lake Snipsic)                | 0.0                                |
| Tolland    | Ellington                    | Village drilled well<br>225 feet deep                | 0.05                               |
| Windham    | Putnam                       | Public surface water supply<br>(Little River)        | 0.0                                |
| Windham    | Thompson<br>(Mechanicsville) | Village deep well<br>440 feet deep                   | 0.05                               |

\*Analyses by Bureau of Laboratories, Connecticut State Department of health.

Note: This tabulation and other examinations indicate practically no fluorides in Connecticut surface water supplies and relatively small amounts even in deep well supplies.



### **Method For Topical Application of 2 per cent Sodium Fluoride.**

1. Give teeth a thorough prophylaxis.
2. Isolate the teeth to be treated with cotton rolls. One quadrant of the mouth at a time is most successful.
3. The teeth in the quadrant being treated are thoroughly dried with compressed air or chip blower. Special care is taken to eliminate all moisture from the occlusal and interproximal surfaces.
4. Paint the dried surfaces with 2 per cent sodium fluoride solution. The solution is "pumped" into the occlusal fissures and interproximal spaces until all exposed parts of the teeth are thoroughly bathed with the solution.
5. Allow the painted surfaces to dry in air approximately four minutes. **Do not use chip blower or compressed air to hasten drying.**
6. Remove cotton rolls and discard them. Proceed to the remaining three quadrants of the mouth and treat similarly.
7. When all treatment is completed remove cotton rolls and dismiss patient.



## **Report of Council on Dental Therapeutics of the American Dental Association.**

At its annual meeting, held in Chicago on March 7 and 8, 1947 the Council on Dental Therapeutics of the American Dental Association adopted the following statement with regard to topical application of fluorides for prevention of dental caries:

*"The evidence is convincing that fluoride solutions properly applied to the teeth are capable of a limited inhibiting effect on tooth decay in children considered collectively. However, the method is associated with many unknown factors, among them being the optimum frequency of administration, optimum strength of solution, local conditions for maximum adsorption and the mode of action by which fluorine so applied exerts its influence. Despite these shortcomings, it appears to offer a way to reduce the incidence of caries significantly with relative safety in a highly susceptible population and is deserving attention as a public health measure of potential importance. Although the optimum concentration of fluorine is not known, most of the available evidence is associated with multiple application of 2 per cent aqueous sodium fluoride solutions preceded by oral prophylaxis."*

*JADA May 15, 1947*







Gaylord

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